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# A measurement of the lifetime of the first excited state in $Tl^{200}$

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With 1 figure in the text

The lifetime of the 148 keV level in $Tl^{200}$ has been remeasured with greater accuracy than before (3) and a halflife of $7.3 \pm 0.3$ mμs has been found.

The levels in $Tl^{200}$ have been studied from the decay of $Pb^{200}$ (21.5 h) by several authors (1, 2, 3) and a decay scheme partly checked by electron-electron coincidences has been suggested by Bergström and Wapstra (1). The gamma transition from the first excited level of 148 keV has been shown to be an $E2$ transition with less than 3% $M1$ admixture (3). B. Åström *et al.* (3) have measured the halflife of this level by delayed coincidences in a $\gamma$–$\gamma$ scintillation spectrometer. In the present work the halflife of the level has been remeasured using the same technique but with better time resolution and in an electron-electron coincidence spectrometer.

$Pb^{200}$ was produced by bombarding thallium in the synchro-cyclotron in Uppsala with protons of a suitable energy to give maximum yield of the $(p, 4n)$ reaction. After chemical separation the lead was evaporated onto an aluminum foil of 0.2 mg/cm².

The measurements were made with a coincidence unit of the type described by R. E. Bell (4) and an electron-electron coincidence spectrometer was used for the energy resolution (5). As detectors we used RCA 6810A photomultipliers provided with plastic scintillators.

The spectrometer was set to a transmission of 3% and a resolution of 3% in both channels. In one spectrometer the $L$-conversion electrons of the 148 keV transition were focused and in the other the $K$-conversion electrons of the 142 keV transition. The conversion electrons from the 148 keV transition passed through the backing of the source. The resolving time of the coincidence unit was set to about 8 mμs.

Because of the limited length of the variable delay line the entire curve could not be scanned in one run, but had to be divided into two parts. In fig. 1 the background is subtracted and the two parts are normalized to the same height in the joint. From the slope of the curve the halflife of the 148 keV level was found to be $7.3 \pm 0.3$ mμs, in agreement with the value found by Åström *et al.* (3) $8 \pm 2$ mμs.

Under the assumption that the 148 keV gamma ray is a pure $E2$ transition the experimental transition probability was derived from the formula: $P_{\text{exp}} =$

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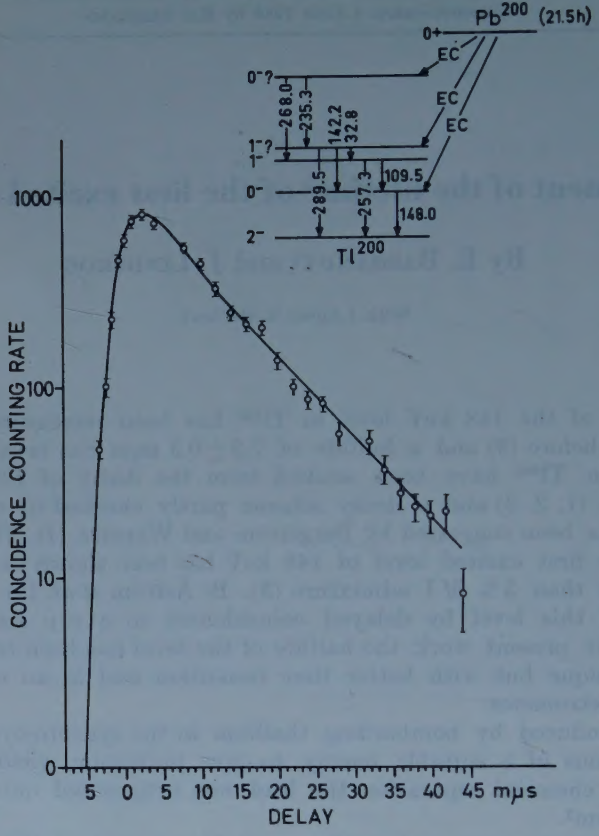

Fig. 1. Plot of delayed coincidences from the first excited state in $Tl^{200}$.

$0.693/[T_{\frac{1}{2}}(1+\alpha_{\text{tot}})]$. The $\alpha_{\text{tot}}$ was taken from the tables published by M. E. Rose (6). All the partial conversion coefficients from $\alpha_K$ to $\alpha_{MV}$ were taken into account. The experimental transition probabilities were compared with the $\gamma$-ray transition probabilities in terms of the Single Particle Model (7), where the transition probability is given by:

$$P_{\text{SPM}}(E\,2) = 7.4 \times 10^7 \times E\gamma^5 \times A^{4/3} \times S.$$

For the nuclear radius the value $a = 1.2 \times 10^{-13} \times A^{1/3}$ was used. The statistical factor was put equal to one. For $Tl^{200}$ we get an enhancement factor $P_{\text{exp}}/P_{\text{theor}}$ equal to 6.8. No other lifetimes of $E\,2$ transitions in odd-odd nuclei are known in this region. However for the even-odd nuclei $Tl^{203}$ and $Tl^{205}$ enhancement factors of the same order of magnitude are reported. For $Tl^{203}$ 9.9 (7) for $Tl^{205}$ 4.9 (8).

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*Note*: When this work was completed a measurement of the lifetime of the 148-keV level in $Tl^{200}$ was published by B. Johansson *et al.* (9). From coincidences between 148-keV $\gamma$-rays and X-rays following electron capture they found $T_{\frac{1}{2}} = 7.1 \pm 0.15$ mμs.

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